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PRINTING DIGITAL DOCUMENTS

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CROSS REFERENCE TO RELATED APPLICATIONS

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6 This application is related to the following Patent Applications: US
7 Patent Application Serial No._____ filed September 10,
8 2003, entitled "Methods and Apparatus for Generating Images" (HP
9 reference 200207059-1 US; Attorney docket 621240-1); US Patent
10 Application Serial No._____ filed September 10, 2003,
11 entitled "Location Patterns And Methods And Apparatus For
12 Generating Such Patterns" (HP reference 200310542-1; Attorney
13 docket 621241-9); US Patent Application Serial No._____
14 filed September 10, 2003, also entitled "Location Patterns And
15 Methods And Apparatus For Generating Such Patterns" (HP
16 reference 200310543-1; Attorney docket 621242-7); British Patent
17 Application No._____ filed September 10, 2003, entitled
18 "Methods, apparatus and software for printing location pattern" (HP
19 reference 200300566-1; Attorney docket JL3824); and, British Patent
20 Application No._____ filed September 10, 2003, entitled
21 "Printing of documents with position identification pattern" (HP
22 reference 200310132-1; Attorney docket ASW1329).

23

24

BACKGROUND OF THE INVENTION

25

26 This invention relates to printing digital document, and to digital pen
27 and paper systems- sometimes called pen computing- in which
28 documents are produced that include position identification pattern
29 made up of markings printed on the document which can be detected
30 by a suitable detection system and used to distinguish different
31 positions on the documents. It also relates to a system for same and

1 to a combination of a printer and a printer driver. It is especially, but
2 not exclusively, relevant to the generation of digital documents.

3
4 It is known to use documents having such position identification
5 markings in combination with a pen or other device having an
6 imaging system, such as an infra red camera, within it, which is
7 arranged to image a small area of the page close to the pen nib. The
8 pen includes a processor having image processing capabilities and a
9 memory and is triggered by a force sensor in the nib to record
10 images from the camera as the pen is moved across the document.
11 From these images the pen can determine the position of any marks
12 made on the document by the pen. The markings can be stored
13 either directly as graphic images, or perhaps as a sequence of
14 "strokes/position on the document/time", which can be passed from
15 the pen to a suitable processor such as a personal computer.

16
17 The combination of the pen and the patterned paper allows, for
18 example, forms with checkboxes on to be provided and the markings
19 of the check boxes with the pen detected. In further applications the
20 pen markings recorded by the pen may be analysed to recognise
21 handwriting characters.

22
23 For such a system to be able to handle a large number of documents
24 it is desirable for the system to be able to print a different pattern on
25 every document. In this way, the pen cannot only tell where it is on a
26 document but also what document it is. The size of the pattern, its
27 so-called area in pattern space, should be made very large and the
28 allocation of portions of the pattern to documents recorded. By
29 recording the portion of pattern allocated to each document on a
30 database, which can be cross-reference with the pen readings and

1 also a store of the document contents, a very flexible and powerful
2 system can be achieved.

3
4 An example of a system which employs this type of digital paper is
5 known from Anoto AB, and information about the requirements for a
6 suitable pattern can be found on their website at www.anoto.com.

7
8 At present, production of documents including pattern is a two-pass
9 process in which a batch of patterned paper is produced using a
10 technique such as offset printing. Once this blank patterned paper has
11 been printed, a user can create a file which contains the content (i.e.
12 all printed parts of the document other than the pattern) and a
13 second print pass is made in which the content is printed over the top
14 of the pattern. This is a slow and cumbersome process and limited
15 availability of pre-printed blank paper may limit the speed and
16 convenience at which digital documents can be produced.

17 SUMMARY OF THE INVENTION

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19
20 In accordance with a first aspect the invention provides a method of
21 printing a document containing a printed pattern of position
22 identification pattern markings comprising:
23 providing to a printer a set of print instructions which define the
24 content of a document;
25 generating at the printer a pattern using pattern information that is
26 independent from the print instructions;
27 and printing a digital document that combines both content as
28 defined by the print instructions and the pattern generated by the
29 printer.

30

1 Thus, according to at least one embodiment of the invention there is
2 provided the advantage that the printer creates the required pattern
3 to print a digital version of the document, enabling it to be used in a
4 digital pen and paper system. Because the printer generates the
5 pattern - as distinct from sending to the printer a complete
6 description of the pattern with the content of the document- the
7 amount of information that needs to be sent to the printer is reduced.
8

9 It will be understood that by the phrase "pattern information that is
10 independent from the print instructions" we mean information that
11 does not form part of the file or files sent to the printer which make
12 up the document it is asked to print. By print instruction we mean any
13 instructions which can be sent to a printer and which can be in any
14 format that is understood by a printer, the pattern instructions being
15 provided as part of those instructions. The print instructions could
16 define a document which is blank other than for pattern, i.e. it has a
17 blank content.
18

19 The print instructions may include at least one pattern instruction
20 indicating that a pattern is to be added by the printer to the document
21 and the printer adds a pattern to the printed document in response to
22 the at least one pattern instruction. The size of the description (the
23 file of instructions sent to the printer) can therefore be greatly
24 reduced. This reduces the time taken to transmit the file to the
25 printer, freeing up the host to perform other tasks. Also, since the
26 task of generating/allocating the actual pattern is performed at the
27 printer the host is further freed to perform other tasks.
28

29 The pattern instruction could be included in the set of print
30 instructions in many forms. It could simply be an instruction to "add a
31 pattern" to the whole or part of a document. It could be an identity

1 (ID) instruction which identifies a portion of pattern from a pattern
2 space, or the type of pattern to be allocated or an algorithm that may
3 be used to generate it.. In some cases the pattern instruction can be
4 thought of as a request for the printer to "add this pattern" or "add
5 this portion of pattern" when printing.

6
7 The additional, independent, pattern information used by the printer
8 that is not included in the print instructions may be stored locally at
9 the printer- perhaps in a permanent memory- or remotely on a device
10 which can be accessed by the printer across a network.

11
12 In a notable arrangement the description sent to the printer may
13 include a pattern instruction which comprises an address. This
14 address may indicate the location of a server on a network to which
15 the printer is connected. The printer can request a pattern from this
16 server to include in the document or request the additional
17 information needed to create the pattern.

18
19 This provides the still further benefit that the processing overheads
20 involved in allocating or generating the actual pattern for the printer
21 are passed onto a remote processor (identified by the address) which
22 frees the host and the printer to get on with other tasks. The host
23 does not in fact need to have any direct connection to the processor
24 that allocates or generates the pattern, allowing the document to be
25 created "off-line" without any access to applications for the
26 generation of the pattern.

27
28 This later feature is of great benefit in at least one system in which a
29 document is created and allocated a pattern for subsequent printing.
30 The document and an ID indicating which portion of pattern is to be
31 used are stored on a server, and a user is given only the document

1 and pattern ID. When a user is ready to print the document and ID
2 are sent to the printer and the printer itself retrieves or generates the
3 actual pattern identified by the ID. Of course, if the printer is given
4 enough "intelligence" to create the pattern itself from the ID (by a
5 stored function, library or look-up table) then the link to the server
6 could be removed.

7

8 It will be appreciated that printer could be a stand-alone device which
9 incorporates all of the features needed to generate and print pattern.
10 The function of a pattern allocating server described hereinbefore
11 could be included in the printer enabling it to allocate and generate
12 pattern without the need to contact an external server.

13

14 A further advantage of providing a link from the printer to a server
15 which sends pattern information is that security rights can be
16 attached to the document. For example, the printer may identify itself
17 to the server when requesting pattern and the server can check that
18 the printer has the appropriate permission to print the document
19 associated with the pattern ID.

20

21 In a still further alternative the instructions sent to the printer
22 comprise pattern instructions telling the printer where to print pattern
23 markings whilst leaving the actual generation of the markings to the
24 printer itself. The printer is therefore sent compressed pattern
25 information- a sort of shorthand of what the pattern comprises- whilst
26 the printer fills in the missing information to produce the required
27 image in the device space.

28

29 This last arrangement has the advantage that the pattern is produced
30 independent of the resolution of the printer. Once it has been told the
31 layout of the pattern- i.e. where the markings go- the printer can

1 produce the actual pattern in the best way it can, choosing the
2 appropriate markings and deciding for itself exactly how to reproduce
3 the pattern that has been requested and where exactly to place them
4 in the printed document. This reduces the amount of knowledge that
5 the host- and in particular the printer driver- needs to have of the
6 exact capabilities of the printer such as the printer resolution.

7

8 The method may further comprise generating the pattern in pieces
9 that are smaller than the whole pattern needed for the document, a
10 first piece being generated and the portion of the document including
11 that piece being printed before, or during the generation of one or
12 more of the remaining pieces. This may be continued until the whole
13 document is printed.

14

15 Each piece may comprise a band of the document. Generating
16 pattern in this way, and sending the piece with the corresponding
17 content to be printed reduces the amount of memory needed to store
18 the pattern during printing.

19

20 According to a second aspect the invention provides apparatus for
21 printing a document containing position identification pattern
22 markings which includes a printer having an processing means
23 arranged to create the pattern to be printed in response to receipt of
24 a set of print instructions which define the content of the document,
25 the processing means creating the pattern using pattern information
26 that is independent from the set of print instructions.

27

28 The apparatus may comprise either a stand-alone printer which can
29 be connected to a host device such as a personal computer, or could
30 comprise a part of a photocopier. The copier could be multifunctional
31 allowing it to function as a printer or as a photocopier. When

1 functioning as a printer it will receive documents to print
2 electronically across a network. Where it functions as a photocopier
3 it captures documents using a scanner.

4

5 Where a photocopier is provided, the set of print instructions will
6 comprise a set of output signals generated by a scanner of the
7 photocopier when an original document is scanned. Where it is a
8 stand alone printer it will comprise a print file sent by a host device to
9 the printer, or perhaps pre-stored in an area of memory of the printer.

10

11 Whilst appreciating the advantages that can be obtained by providing
12 a printer or a copier that can print digital documents, the applicants
13 have realised that it is in many cases advantageous to provide for a
14 way of identifying copies that are printed.

15

16 According to a third aspect the invention provides a method of
17 printing a document comprising:

18 receiving a set of print instructions defining the content of a
19 document;

20 generating a set of different patterns of position identification
21 markings; and

22 printing a plurality of copies of the document in which each printed
23 copy comprises both the content and one of the patterns of the set.

24

25 According to a still further, fourth, aspect the invention provides
26 apparatus arranged to produce multiple copies of a source document
27 comprising:

28 receiving means for receiving a set of print instructions defining the
29 content of the source document;

30 processing means for generating a set of different patterns or
31 portions of pattern; and

1 printing means for printing a plurality of copies of the source
2 document in which each printed copy comprises both the content of
3 the source document and one of the patterns of the set.

4

5 The means for adding the pattern to the document may reside at the
6 printer, allowing the advantages of reduced file size of the first
7 aspect of the invention to be combined with the ability to print many
8 different copies. Alternatively, the means for adding pattern may
9 reside on the host computer and as such may comprise a printer
10 driver or a filer driver.

11

12 Also, as indicated before, the apparatus may comprise a stand alone
13 printer driver or perhaps a digital photocopier. Where it comprises a
14 photocopier the apparatus may also include an optical scanner for
15 scanning the source document and producing output signals
16 representing an image of the source document to which the pattern is
17 added, the processing means comprises an image processor for
18 performing at least one processing step on the output signals
19 produced by the scanner to produce modified signals representing a
20 modified image of the scanned document, and in which the printing
21 means is responsive to the modified image signals for printing a
22 modified image represented by the modified image signals.

23

24 With the photocopier the processing step performed by the processor
25 comprises embedding a pattern of positional markings within the
26 image of the scanned document which markings can be detected by
27 a suitable detection system and used to distinguish different
28 positions on the documents.

29

30 The processing step performed by the processing means may
31 comprise embedding a different pattern of positional markings within

1 each of the modified images in the set which markings can be
2 detected by a suitable detection system and used to distinguish
3 between different positions on the documents.

4

5 It is preferred that the copy documents differ in that they each
6 include a different portion or type of positional marking pattern.
7 However, they may differ in other ways such as the addition of a
8 barcode or a serial number or other marking. These may be visible to
9 the human eye and/or may be machine readable markings.

10

11 According to a fifth aspect, the invention provides a photocopier
12 comprising:

13 i) an optical scanner for scanning a document and producing output
14 signals representing an image of the scanned document;

15 ii) an image processor for performing at least one processing step on
16 the output signals produced by the scanner to produce modified
17 signals representing a modified image of the scanned document; and
18 iii) a printer responsive to the modified image signals for printing a
19 modified image represented by the modified image signals;

20 and wherein the processing step performed by the processor
21 comprises embedding a pattern of positional markings within the
22 image of the scanned document which markings can be detected by
23 a suitable detection system and used to distinguish between different
24 positions on the documents.

25

26 The invention, therefore, in one aspect enables a photocopier to
27 make digital documents whenever it makes a photocopy.

28

29 By adding a pattern of positional markings to the document when
30 making a photocopy the apparatus enables a document to be
31 photocopied as a "digital document". This permits the document to be

1 used in any of a variety of digital paper systems depending on the
2 pattern used, thus adding considerable value to the photocopy.

3
4 Where the apparatus is a photocopier it may include means for
5 storing the copy information and the printed information on a server.
6 This provides a record of the document. The printed information may
7 be stored as an electronic image of the copied document.

8
9 It is envisaged that the copier may add a different pattern each time
10 a copy is made of a particular document. In that case a single source
11 document can be provided which can be passed through the
12 photocopier many times to add additional information- represented
13 by the pattern- which is different for each copy. Alternatively, the
14 copier may be set up to add a different pattern each time a batch of
15 copies are made, or perhaps add a pattern that is specific to a user.
16 For example, a user may be required to enter an ID, password or
17 other code on the photocopier which is unique to that user. Pattern
18 can then be added which is unique to that user according to the ID,
19 password or code entered.

20
21 The copier may access a server to determine which pattern to add.
22 The server could reply to a request made by the copier across a
23 network by sending the copier a portion of pattern or perhaps a
24 pattern ID identifying the portion of pattern to be added. In exchange,
25 the copier could send to the server an electronic image of the
26 document which can be linked to the portion of pattern.

27
28 The server may therefore form a part of a "digital paper" processing
29 system. In one aspect of the present invention, the document
30 including the pattern will comprise a photocopy which includes the
31 pattern. The original of the document need not be designed as a

1 digital document, and may indeed have no indication that it is to be
2 printed with a pattern. Once the copier has added the pattern and
3 sent an electronic image of the original to the server to be stored in a
4 related way with its pattern, it enters the digital domain. Information
5 obtained by the pen as it writes on the document may be interpreted
6 by the server to determine which document is written on and where.
7 The recorded strokes may then be processed by a suitable
8 application which handles the image of the document, the pattern
9 and the strokes.

10
11 Where the photocopier detects that an original document to be/being
12 photocopied already contains a pattern of positional markings, it may
13 offer the user an option to print without pattern, with the original
14 pattern or with the pattern replaced by a new pattern.

15
16 According to a still further aspect the invention provides a controller
17 for a photocopier and a data carrier which carries program
18 instructions which when processed by a controller of a photocopier
19 cause the controller to perform the method of the aspect of the
20 invention or provide the apparatus of the aspect

21 22 BRIEF DESCRIPTION OF THE DRAWINGS

23
24 **Figure 1** shows a document printed according to one embodiment of
25 the invention;

26
27 **Figure 2** shows in detail part of the document of Figure 1;

28
29 **Figure 3** shows a computer system arranged to process information
30 from the form of Figure 1;

31

1 **Figure 4** shows a prior art pen for use with the document of Figure 1;

2

3 **Figure 5** shows an example of a system for creating and printing the
4 document of Figure 1;

5

6 **Figure 6** is a flowchart of the steps followed in the creation of a
7 suitable document for printing;

8

9 **Figure 7(a)** is a general overview of one exemplary embodiment of a
10 printing system for the printing of documents in accordance with the
11 present invention;

12

13 **Figure 7(b)** is an overview of an alternative exemplary embodiment
14 of a printing system for the printing of documents in accordance with
15 the present invention;

16

17 **Figure 8 (a)** illustrates in more detail the workflow for a first
18 embodiment of a printing system in accordance with the invention;

19

20 **Figure 8 (b)** illustrates in more detail the workflow for a second
21 embodiment of a printing system in accordance with the invention;

22

23 **Figure 8 (c)** illustrates in more detail the workflow for a third
24 embodiment of a printing system in accordance with the invention;
25 and

26

27 **Figure 8 (d)** illustrates in more detail the workflow for a fourth
28 embodiment of a printing system in accordance with the invention.

29

30 **Figure 9(a)** is an overview of an embodiment of a photocopier in
31 accordance with one aspect of the present invention;

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Figure 9(b) is a schematic illustration of the photocopier controller;

Figure 10 is a flow chart of the steps that are performed in producing a digital document using the copier of Figure 1 of the accompanying drawings;

Figure 11 is a schematic illustration of an apparatus for processing digital documents; and

Figure 12 is a flowchart of the steps performed when using the apparatus of Figure 11 to manage copies of documents.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to Figure 1 a printed “digital” document 100 for use in a digital pen and paper system comprises a carrier 102 in the form of a single sheet of A4 paper 104 with position identifying markings printed on some parts of it to form areas 107 of a position-identifying pattern 108. This background markings are referred to as “pattern” in this text. Also printed on the paper 104 are further markings 109 which are clearly visible to a human user of the form, and which make up the content of the document. The content 109 will obviously depend entirely on the intended use of the document. In this case an example of a very simple two-page questionnaire is shown, and the content includes a number of boxes 110, 112 which can be pre-printed with specific information such as the users name 114 and a document identification number 116.

1 In the past, the pattern has been printed in a first pass, typically
2 using offset printing techniques with the content being printed over
3 the top in a second pass or in a single pass using high cost offset
4 printing. In this example, a method in which the content and pattern
5 are printed in a single pass is described.

6
7 It is envisaged that the position-identifying pattern that is printed may
8 have many forms but one suitable example is that shown in Figure 2.
9 The position-identifying pattern printed on the document is made up
10 of a number of dots 130 arranged on an imaginary grid 132. The grid
11 132 can be considered as being made up of horizontal and vertical
12 lines 134, 136 defining a number of intersections 140 where they
13 cross. One dot 130 is provided at each intersection 140, but slightly
14 offset in one of four possible directions up, down, left or right, from
15 the actual intersection. The dot offsets are arranged to vary in a
16 systematic way so that any group of a sufficient number of dots 130,
17 for example any group of 36 dots arranged in six by six square, will
18 be unique within the pattern space. An example of this type of
19 pattern is described in WO 01/26033. It will be appreciated that other
20 position identifying patterns can equally be used. Some examples of
21 other suitable patterns are described in WO 00/73983 and WO
22 01/71643.

23
24 Referring to Figure 3 an internet based system for using the
25 document 100 comprises a pen 300 arranged to write on the
26 document 100 and to detect its position on the document from the
27 pattern 108, and an internet connected personal computer (PC) 302
28 arranged to run an application for processing data from the pen 300,
29 for example by modifying a file in which the document 100 is stored
30 electronically in response to pen strokes made on the document 100
31 with the pen 300. The PC 302 includes a user interface including a

1 screen 314, a keyboard 316 and a mouse 318, as well as a
2 processor, a memory, and I/O software devices by means of which
3 the processor communicates with the screen 314, the keyboard 316,
4 the mouse 318 and a communications port by means of which it
5 communicates with the internet. The system also includes an internet
6 connected server 304 referred to here as an EPLS (electronic paper
7 look-up service) which has stored on it database of records of which
8 areas of the pattern space are allocated to which printed copies of
9 documents.

10

11 An application service handler (ASH) 306, which is a program run, in
12 this case, on a separate server having its own memory, processor
13 I/O devices and communications port, is also provided with Internet
14 connection. The ASH 306 is arranged to interpret the pen strokes
15 recorded by the pen 300, as described below, converting them to an
16 input suitable for the application on the PC 302. The ASH includes
17 an optional image character recognition (ICR) program so that it can
18 interpret handwritten input on the document 100 and convert it to
19 digital text. A further ASH 307 is also provided, and is associated
20 with a different application and arranged to interpret pen strokes for
21 that application. In this case there is one ASH for each application
22 that makes use of the digital pen and paper system. Each ASH 306,
23 307 needs to have a record of the layout of any particular document
24 100 including the positions, dimensions and functions of each of the
25 patterned areas so that it can process any pen strokes made on the
26 document 100.

27

28 A local paper lookup service (LPLS) 309 is also provided on the
29 users PC which has an internet connection. This is a proxy service
30 arranged to receive data from the pen when the pen has been used
31 on the document 100, the data identifying which areas of pattern

1 space have been written on. Typically the pattern space that is
2 associated with the send box 122, and which the pen 300 has
3 recognized as a prompt to contact the LPLS, is identified to the LPLS
4 309. The LPLS may be able to determine from locally held data
5 which ASH to use to process the pen information. If not, the LPLS
6 309 is arranged to interrogate an Enterprise paper look-up service
7 (EPLS) database on a central, network connected server 304 to
8 determine the unique identity of the printed copy of the document
9 100. The EPLS includes a database indicating which application a
10 printed copy of a document is associated with, and therefore which of
11 the ASHs 306, 307 should be used for that application. The EPLS
12 identifies the appropriate ASH 306 and the document identity to the
13 pen. The pen can then send the pen stroke data and the document
14 identity to the correct ASH 306, 307.

15

16 It will be understood that the various components of the system can
17 all be located at separate locations, communicating via the internet
18 as described. Alternatively some or all of them could be provided
19 together on a single server, or grouped on a local network. This
20 might be appropriate where a self-contained system for a limited
21 number of applications is required.

22

23 Referring to Figure 4, the pen 300 comprises a writing nib 310, and a
24 camera 312 made up of an infra red (IR) LED 314 and an IR sensor
25 316. The camera 312 is arranged to image a circular area of
26 diameter 3.3mm adjacent to the tip 311 of the pen nib 310. A
27 processor 318 processes images from the camera 312 taken at a
28 specified sample rate. A pressure sensor 320 detects when the nib
29 310 is in contact with the document 100 and triggers operation of the
30 camera 312. Whenever the pen is being used on a patterned area of
31 the document 100, the processor 318 can therefore determine from

1 the pattern 108 the position of the nib of the pen whenever it is in
2 contact with the document 100. From this it can determine the
3 position and shape of any marks made on the patterned areas of the
4 document 100. This information is stored in a memory 320 in the pen
5 as it is being used.

6
7 When the user has finished marking the document, in this case when
8 the questionnaire is completed, this is recorded in a document
9 completion process, for example by making a mark with the pen in
10 the send box 122. The pen is arranged to recognise the pattern in
11 the send box 122 and determine from that pattern the identity of the
12 document 100. It then sends this document identification information
13 to the EPLS server 304, which identifies the relevant ASH 306 to the
14 pen 300, by sending the network address (e.g. a URL) of the ASH
15 306 to the pen 300. The pen stroke data is then sent by the pen 300
16 to the ASH 306 which converts it to a suitable format for input to the
17 application 402. The pen 300 can be connected to the network in any
18 suitable manner, but in this case it is via a Bluetooth radio link with
19 the PC 302. Suitable pens are available from Logitech under the
20 trademark Logitech Io using a USB connection.

21
22 In order to produce a set of digital documents 100, the first step is
23 the design and creation of the document content. Referring to Figure
24 6 this starts at step 600 with the design of the content of the
25 document, which is carried out on the PC using the application 402
26 or some other application. In this case the application is Acrobat
27 Writer and the PC 302 also runs a number of other applications
28 including a word processing package such as 'Word' a database
29 package such as 'Access', and a spreadsheet package such as
30 'Excel'. Each of these can be used to design the content of the
31 document. Then the areas of the document to which the pattern 108

1 are to be applied are defined by the user. In this case this is carried
2 out using a form design tool (FDT) 416 in the form of an Acrobat 5.0
3 plug-in. The content is therefore converted to PDF format at step
4 602, and the pattern areas defined using the FDT 416 at step 604,
5 producing a digital document defining both the content and the
6 positions and shapes of the pattern areas.

7

8 The user may also define functions associated with the various
9 patterned areas defined at step 606 so that the application 402 can
10 process data received back when the document 100 has been written
11 on. The defined functions are then allocated to the pattern areas at
12 Step 606. In the case of the questionnaire document 100 the pattern
13 areas in the larger boxes 120, 121 are identified as a graphical input
14 areas, for which any pen markings should be stored graphically, or
15 perhaps analysed using character recognition and stored as text. The
16 regions associated with the check boxes 118 is associated with the
17 respective response options so that the checking of the boxes 118 on
18 a number of the forms 100 produces a standard mark, such as a
19 cross, in the check box of the stored document. The region
20 associated with the send box 122 is associated with the send
21 function which will cause the pen to stop recording pen strokes for
22 the document 100 and send them to the LPLS 309.

23 Once the document 100 has been designed, the user indicates, using
24 the FDT 416 that it is completed, and the FDT 416 saves the
25 document as a PDF file and allocates a document name to the
26 document 100 in step 610 as indicated above. The FDT 416 also
27 creates a Paper Application Definition (PAD) file which is a file
28 defining those features or parameters of the document 100 that will
29 be needed by the ASH 306 to interpret pen strokes made on the
30 document 100. Those parameters include the size and shape of the
31 pattern areas, and their functions, such as whether they are check

1 boxes, areas for graphical input, areas for ICR analysis or areas
2 having other functions. These parameters are the ones necessary to
3 allow the processing of pen strokes made on the document 100 using
4 the pen 300.

5
6 The PAD file is transmitted to the EPLS 306 when the document 100
7 has been finished and before it is written on with the pen. There it is
8 added to the database to be updated or linked to pattern portions
9 once pattern has been allocated at print time, so that it is accessible
10 to the ASH which can interpret pen strokes on the document 100 and
11 produce the necessary inputs to the application 402. The pattern
12 space area allocated to the send box 122 also needs to be identified
13 to the pen 300 so that it can detect when it is written on and respond
14 by sending the pen stroke data. This occurs after the form design
15 and is explained in more detail in the following description.

16
17 Having defined a document and defined the regions within that
18 document to which pattern is to be allocated the user is ready to print
19 the document. The printing of the document- comprising the content
20 and the pattern is achieved in a single pass process using any
21 printer that has a sufficient resolution to produce the dots of the
22 pattern. Figure 7(a) shows an overview of the functional units of a
23 suitable printing system according to an embodiment of the present
24 invention, which in this example comprises a computer 700 that the
25 document is stored on prior to printing and a printer 710 which is
26 connected to the computer. The computer provides an application for
27 viewing and/or editing the document to be printed (for example
28 Acrobat Reader) and a printer driver application which produces a
29 set of print instructions. The printer includes a print controller which
30 receives the print instructions from the printer driver and in turn

1 prints the document. Optionally, the system includes a pattern
2 allocation unit 720 which stores pattern information.

3
4 When a user decides to print a document, print on demand (POD)
5 tool is called up from the application. In a typical graphical user
6 interface, such as Microsoft Windows, running a word processing
7 package to design a form, such as Word 6.0, calling the printer driver
8 is performed by selecting "file" then click "print" in the drop down box
9 that appears below. This will start the printer driver which will initiate
10 the display of a set of visual prompts on the screen to which the user
11 can respond. These prompts may include the option to print the
12 document with or without pattern.

13
14 Once the user has responded to the prompts called, the POD takes
15 the file- a PDF file in this example- produced by the application
16 sends a stream of print instructions to the printer driver which in turn
17 creates from these a print file in a page description language (PDL)
18 describing the arrangement of any text and graphics forming the
19 content in the document. Many different PDL languages could be
20 used such as PCL developed by Hewlett Packard or Postscript
21 developed by Adobe Systems.

22
23 The printer driver may produce a set of PDL instructions defining the
24 content which also include one or more pattern instructions.
25 Alternatively, the driver may produce a set of PDL instructions for the
26 content which are accompanied- or "wrapped up" by instructions
27 written in a higher level language which include pattern instructions.
28 How this is done depends on the languages understood by the
29 printer. The format of the PDL part of the file will depend upon the
30 type of printer to which the file is to be sent but will most likely be
31 either as a PCL or Postscript format file.

1

2 In one arrangement, for example, the content may be written in the
3 PCL language and the pattern instruction(s) may comprise
4 commands written in the printer job language (PJM) such as that
5 described in the PJL Technical Manual, 10th edition that can be
6 obtained from Hewlett Packard and is suitable for the control of many
7 HP printers. In the event that the instructions are sent to a printer
8 that does not support PJL, the pattern commands in the PJL part of
9 the file will print as ASCII characters and the document will be
10 printed without pattern. This feature may be beneficial with older
11 printers that are not capable of printing the pattern as the document
12 content will still print.

13

14 The printer can read the PJL file as it is provided with a converter-
15 sometimes called a raster image processor (RIP)- which understands
16 the PJL language. The raster image processor is essentially a
17 dedicated processor built into the printer architecture, which converts
18 the instructions sent by the printer driver into a full-page bitmap.

19

20 Figure 8(a) of the accompanying drawings illustrates in more detail
21 the work flow of a first embodiment of a printing system starting at
22 the left edge of the page with the FDT application which views the
23 document and ending towards the right edge of the page with the
24 print engine which outputs the printed document.

25

26 In this embodiment the print instructions sent to the printer are
27 prepared at the printer driver of the host PC 700 and include at the
28 start of the file a new PJL command which provides a
29 metadescription of the pattern. This command is in the form of a
30 pattern ID which identifies that a pattern is to be included in the
31 document. Assuming the document produced by the FDT contains

1 regions which are defined as including pattern, the driver allocates
2 pattern to these regions and identifies the portion of pattern allocated
3 by a pattern ID which is included in the file sent to the printer.
4 Pattern allocation is performed by the printer driver making a request
5 to a pattern allocation unit (as also shown in Figure 3) which forms
6 part of the EPLS server although it could be held elsewhere. The
7 PAD file is updated or linked at the EPLS with the allocated pattern
8 information.

9
10 An example of a suitable pattern instruction written in PJP is as
11 follows:

12
13 @PJP SET DIGITAL-PATTERN = " string"
14

15 Where @PJP tells the printer it is a PJP command, DIGITAL-
16 PATTERN tells the printer to call the function for creating the digital
17 pattern and the string is the pattern information passed to the
18 function.

19
20 The printer, which as described understands the PJP language of the
21 print file has access to a memory in which is stored an algorithm of
22 the generation of pattern. The new DIGITAL-PATTERN command for
23 the pattern ID is also added to the print engines vocabulary. The RIP
24 parses the instruction file by reading the instructions and calling the
25 appropriate functions defined by the instructions. For example, when
26 a PJP command identifying a pattern ID is read in the instructions the
27 RIP calls a function that executes an algorithm using the value of the
28 ID as its input variable. The function produces a bitmap file
29 corresponding to the required image.

30

1 The pattern produced by the DIGITAL_PATTERN function depends
2 on the values held in the string. The values passed by the command
3 will depend on the way in which the function is defined at the printer,
4 but typical string syntax in PJI may be as follows:

5

6 [PAGE_NUMBER:PATTERN-ID[(X,Y,W,H):PATTERN-ID[(X,Y,W,H)]]

7

8 where PAGE_NO is the number of the page in the document;

9

10 PATTERN-ID is the unique ID of the pattern which can be in
11 the form of co-ordinates as here;

12

13 X,Y,W,H are the position and size of the portion of pattern in
14 the pattern space that is to be printed.

15

16 In the above example, the command passes to the printer the
17 location in x-y coordinates of an area of pattern within the total
18 pattern space, as well as the width and height of the area.

19

20 Of course, other pattern information could be passed in this way. For
21 example, the string may be an ID which when passed to the function
22 called by the DIGITAL_PATTERN command causes the function to
23 generate the required pattern. In a modification of this approach, the
24 ID may be combined with a unique ID stored at the printer to produce
25 an ID which is unique to the combination of document and printer.
26 This will make it possible to identify which printer a document was
27 printed on.

28

29 The use of the command allows other functionality to be included. If
30 multiple pages are present in the document the command can be

1 called with a string that corresponds to each page, a : being used as
2 a separator in the PJP language.

3

4 For example, if the document is a form that is 5 pages long and only
5 pages 2 and 3 have pattern the command may look like:

6

7 @PJP SET DIGITAL-PATTERN="2:1233333,890 3:2344444,901"

8

9 where 1233333,890 and 2344444,901 are the co-ordinates of the
10 pattern portion for pages 2 and 3 respectively.

11

12 Similarly, the command can be used to tell the printer which regions
13 of a page are to be printed with pattern and which are to be blank. It
14 will be appreciated that this can be readily achieved by writing a
15 suitable function that can be called by the printer.

16

17 Once the content and the pattern have been parsed by the RIP to
18 produce bitmap images in the device space these are next combined
19 using a logical bit wise OR function to form a complete
20 pattern/content image in the device space using the canvas directly
21 for rendering. This defines the whole document as a single file. At
22 this time, the document will contain the pattern that corresponds with
23 the pattern that is allocated to it.

24

25 In a final stage, the file comprising the combined content and pattern
26 is sent to a printer engine where the bits of the image are converted
27 to ink (or toner) dots. The file is therefore converted into low level
28 machine instructions for the control of the printer hardware to print
29 the patter, e.g. instruction that move parts of the printer and tell is
30 when to feed the paper or deposit ink or toner or the like. This part of
31 the process is standard printer technology as the combined pattern

1 and content image will appear to the hardware and software as any
2 other document that was to be printed by this stage.

3
4 It is to be noted that when a pattern ID is passed to the printer, the
5 pattern is allocated by the pattern allocation unit prior to printing-
6 typically by the POD tool calling a pattern allocation module which
7 returns with the identity of an appropriate pattern or by the printer
8 driver itself. Generation of the allocated pattern takes place at the
9 printer.

10
11 An alternative flow path for a second embodiment of a printing
12 system is shown in Figure 8(b) of the accompanying drawings. Initial
13 production or viewing of a document using an application is
14 performed in the same manner as the for the first embodiment, as it
15 the calling of the printer driver when it desired to print out the
16 document.

17
18 The primary difference, however, is that in this arrangement the
19 printer does not necessarily receive a file containing a pattern ID for
20 production of a pattern but instead receives a network address
21 indicting the location of a server which acts as a pattern supply unit.
22 The printer engine, on reading the network address in the file
23 contacts the EPLS server identified by the network address and
24 makes a request for a suitable pattern from the pattern allocation
25 unit. The EPLS server returns either a pattern ID, or sends a file in a
26 vector or a bitmap format of the pattern. As such pattern allocation
27 takes place at the printer and typically has not taken place until after
28 the instructions have been sent to the printer.

29
30 The pattern received from the pattern supply unit by the printer is
31 then combined with the content as for the first embodiment and low

1 level machine language instructions are generated for the printer
2 hardware as before.

3
4 As with the first embodiment shown in Figure 8(a), this provides the
5 advantage that the processing overheads of allocating pattern and
6 producing the actual pattern instructions are passed to the printer
7 rather than the processor running the application. The size of the file
8 of print instructions is greatly reduced.

9
10 Of course, it will be appreciated that whilst in the first and second
11 embodiment the insertion of the pattern ID or network address into
12 the document file is made by the application itself when a document
13 file is produced it could equally well be inserted by the printer driver.
14 A suitable plug-in, for example, to an existing application may be
15 provided, or it may be written into the application from the outset. In
16 either case, the PAD file can be updated at the time of selecting the
17 pattern to include the pattern, or may be linked to the appropriate
18 pattern once it has been allocated.

19
20 In another alternative, shown in Figure 8(c) neither the print
21 application nor the POD tool or driver need to allocate any pattern.
22 The definition of a document by an application could simply say "this
23 needs some pattern here" and the printer driver may see this as a
24 prompt to add a prompt to "add pattern here" or a network address to
25 the print instruction set. The actual pattern may then be allocated to
26 the document by a pattern supply and/or allocation unit such as the
27 EPLS server identified by the network address at the request of the
28 printer. The EPLS is notified of the pattern allocated to the printed
29 document and associates this with the PAD file produced during the
30 design of the document.

31

1 Also, it is to be understood that a pattern ID could be included in the
2 print instructions together with a network address, the printer passing
3 the pattern ID to the processor identified by the network address and
4 receiving a corresponding portion of pattern associated.

5

6 The flow path of a still further alternative print system for creating
7 and printing a document with pattern is shown in Figure 8(d) of the
8 accompanying drawings. In this arrangement, the printer is sent
9 instructions on where to print the markings that form the pattern – a
10 set of “put dots here” commands are sent, but the printer is left to
11 decide for itself what the markings should look like and how to create
12 them. As such, pattern allocation AND generation are actually
13 performed at the host rather than the printer. The advantage of
14 reduced instruction set size of the first embodiment are still
15 achieved, as well as the advantage of increased accuracy in the
16 production of the printed pattern.

17

18 In this case, the instructions sent to the printer still comprise PCL
19 instructions wrapped with some PJP commands. Of course, as
20 already stated this is only by way of example and any other suitable
21 printer languages which permit the printer to call up appropriate
22 functions could be used. At the start of the file a set of PJP
23 commands are inserted which each provide a meta description of the
24 location of one or more of the markings of the pattern. By meta
25 description we mean data about other data- in this case data
26 identifying the position of a marking in a document and the type of
27 marking. These commands are each in the form of a command
28 (which tells the RIP it is a position marking) followed by an
29 alphanumeric/numeric variable or string which defines the location of
30 a position marking in the document.

31

1 The location of each marking is determined prior to or during the
2 creation of the print instruction set by the POD tool. The tool
3 allocates a unique instance ID to the printed document 100. It then
4 requests the required amount of pattern space from the pattern
5 allocation unit (which could in some embodiments be the server 304),
6 in this case one page, providing the document name and instance ID
7 to the server 304, and receives back a definition of the required
8 pattern space. This can be, for example, as a full definition of the
9 actual pattern to be used, such as a bit map. The POD tool then
10 generates a set of pattern instructions indicating the location of each
11 of the dots that make up the pattern and adds these to the content
12 instructions to be sent to the printer. Of course, the server could
13 return to the POD with an appropriate set of command instructions
14 rather than sending back an image such as a bitmap.

15

16 Alternatively, the POD tool may support an algorithm which produces
17 the pattern locally without needing to access the server. This pattern
18 generation may be performed by any application at the host, but is
19 most likely to be performed by the POD tool printer driver at the time
20 of printing.

21

22 The printer, which as described understands the PJP language of the
23 print file has access to a memory in which is stored a function that is
24 called whenever a PJP command for a position marking is
25 encountered. The function is called by the command which operates
26 on the string or variable sent with the command. The command
27 returns a portion of bitmap for a dot at the requested location. In this
28 way, the RIP parses the instruction file by reading the instructions
29 and calling the appropriate functions defined by the instructions.

30

1 The command string could correspond to more than one pattern dot,
2 such that each time the function is called a portion of bitmap
3 corresponding to a number of dots is created. This allows further
4 compression of the instructions sent to the printer. For example, for
5 the pattern of Figure 2 a variable comprising a two bit number may
6 be sent indicating whether a marking is above, below, left or right of
7 a grid intersection. A string of such two-bit numbers can be used to
8 identify the location of a group of dots.

9

10 The bitmap produced by the function is inserted into the final bitmap
11 for the document. The exact position at which a marking is to be
12 printed on the document is indicated by the print instructions
13 corresponding to a pattern instruction.

14

15 Once the content and the pattern are produced as bitmap images
16 these are next combined, perhaps using a bitwise OR function, to
17 complete pattern/content image. This defines the whole document as
18 a bitmap file or as a set of PDF instructions (vectors etc) used by the
19 printer to produce the final bitmap.

20

21 In a final stage, the bitmap file comprising the combined content and
22 pattern is sent to a printer engine where the bits of the image are
23 converted to ink (or toner) dots. The file is therefore converted into
24 low level machine instructions for the control of the printer hardware
25 to print the patter, e.g. instruction that move parts of the printer and
26 tell is when to feed the paper or deposit ink or toner or the like. This
27 part of the process is standard printer technology as the combined
28 pattern and content image will appear to the hardware and software
29 as any other document that was to be printed by this stage.

30

1 In some cases, the printer may store a function which corresponds to
2 more than one type of position marking. In this case, the printer may
3 select whichever marking is best to produce the required pattern
4 taking into consideration the resolution of the printer.

5

6 By way of the example shown in Figure 8(d) it should be understood
7 that we may send to the printer an incomplete pattern description
8 which requires the printer to add further detail- such as how to print a
9 pattern marking- to create the pattern. The file sent to the printer
10 may therefore contain a meta description which comprises a
11 compressed representation of the pattern. It may be in the form of a
12 sequence of position instructions identifying where to place a set of
13 dots on the document to form the pattern. In the example of Figure 2,
14 this may be a sequence identifying the location of the dots around
15 the imaginary grid, e.g. left, up, up, right, left etc. Of course, it may
16 also be in some other form which provides only a partial definition of
17 a pattern.

18

19 It will be appreciated that many modifications are possible within the
20 scope of the invention. Any features of one of the embodiments of
21 Figures 8(a) to (d) may be combined with the features of one or more
22 other of the embodiments. The pattern allocation unit may be
23 accessed by the application, the printer driver or the printer
24 depending on the preferred arrangement for a given application.

25

26 A filter driver may be provided which sits in the flow path between
27 the application and the printer driver. This can be seen in Figure 7(b)
28 of the accompanying drawings. As far as the application is concerned
29 this filter will appear to be a printer driver, and will be called in the
30 same way. As far as the printer driver is concerned it will look like an
31 application and will pass instructions to the printer driver in the same

1 way that an application would. The filter drivers function would be to
2 add an appropriate pattern ID or network address or other pattern
3 instructions to the print file as it passes from the application to the
4 printer driver.

5

6 It will also be understood that the paper printed with the pattern and
7 the content can have many uses. A primary use may be in a system
8 for the creation and management of digital documents.

9

10 Another example of a device which falls within scope of at least one
11 aspect of the present invention is a photocopier 910 which can
12 produce digital paper copies of an original source document. This
13 device incorporates many of the benefits of the printers of the first
14 examples, and is shown in Figure 9(a) of the accompanying
15 drawings. It comprises a single piece of apparatus which includes
16 within its main housing a scanner 912 providing an image receiving
17 device and a printer 913 providing an image recording device. These
18 two devices are controlled by a controller 914. The scanner 912 and
19 the printer 913 of the photocopier 910 are essentially standard
20 hardware in the photocopier art and as such will only be explained in
21 brief detail- the skilled man will readily appreciate how these two
22 parts are to be implemented.

23

24 The scanner 912 comprises a glass platen 915 upon which a source
25 document to be photocopied can be placed. The source document
26 could be a printed page, perhaps A4 or A5 or a handwritten
27 document or page from a book leaflet or pamphlet. Indeed, it could
28 be anything that can be reproduced using a photocopier. A cover
29 plate 916 is provided above the platen 915 to block out any
30 unwanted light, and the document is placed between the platen and
31 the cover plate. An optical imaging system comprising a detector-

1 typically a charge coupled device (CCD) line image sensor 917a and
2 a lamp 917b mounted on a motor driven platform 918 are provided
3 below the glass platen 915. The motor driven platform 918 moves the
4 CCD and light across the platen under the control of the controller
5 914 such that the CCD captures a sequence of images, each
6 comprising a slice of the complete image of the document on the
7 platen 915. The CCD of the optical scanner generates as its output
8 electrical signals that digitally represent an image of the document
9 that it has scanned optically. These signals are collated and fed to
10 the controller 914 to form a digital image of the scanned document.
11 The digital image may be gray-scale or colour depending principally
12 upon whether the copier has the ability to print colour copies.

13

14 The printer 913 is typically, but not necessarily, a laser printer. The
15 printer 913 receives electrical signals from the controller digitally
16 representing a modified image of the document and renders this
17 modified image on a copy document. As shown in Figure 9(a) the
18 printer 913 comprises a photoconductive drum 919 and a light
19 exposure apparatus which is adapted to expose the drum to light.
20 The exposure apparatus comprises a laser diode (LD) 920 and a
21 polygonal mirror 921 which is driven by a motor (not shown). As the
22 drum 919 rotates under the control of the controller 914 the
23 polygonal mirror 921 is also rotated to scan a beam of light from the
24 LD 920 across the drum 919. This charges areas of the drum 919
25 which then attract toner from a toner supply 922. The toner forms the
26 modified image on the drum 919. A transport mechanism is provided
27 adjacent the drum 919 to move paper 923 from a feeder unit (not
28 shown) past the drum 919, drawing the paper 923 along as the drum
29 919 rotates. The modified image formed in toner on the drum 919 is
30 thereby passed onto the paper 923. The transport mechanism then
31 carries the paper 923 to a fixing unit 924,925 which comprises a

1 heated roller 24 and a press roller 925. The paper 923 is pressed
2 between these two rollers 924,925 where the modified image is fused
3 to the paper by the heat of the heated roller 924.

4
5 The scanning unit 912 and the printer 913- and indeed all the motors
6 and other parts of the photocopier are controlled by signals produced
7 by the print controller 914. The controller 914 also receives input
8 signals from parts of the photocopier 910 such as a copy button (not
9 shown). The output of the CCD 917b is passed to the controller
10 which produces an initial scanned image. The controller 914 modifies
11 the scanned image by generating a pattern of positional identification
12 markings and modifies the initial image in the digital domain by
13 adding the pattern. The modified image including the pattern is then
14 used to drive the sequence of illumination of the LD which
15 determines the final image that is printed.

16

17 A suitable print controller 1200 is shown in more detail in Figure 9(b)
18 of the accompanying drawings. It may perform a number of
19 operations, such as colour correction or scaling of the image, and, in
20 accordance with the present invention, embedding a pattern of
21 positional markings.

22

23 The print controller 1200 comprises a processor 1210 which is
24 operably connected via a system bus to an area of permanent
25 memory 1220, an area of random access memory 1230, a power
26 supply line 1240 and a modem 1250. The permanent memory 1220
27 provides the function of a data carrier and stores therein a set of
28 program instructions 1260 which can be executed by the processor
29 1210. The operating instructions control the operation of the
30 photocopier controller, and the processor 1210 carries out the
31 instructions in accordance with the program, taking additional input

1 from user performed operations such as the activation of a "start
2 copy" key or an "add pattern" key connected to the bus.

3
4 The program 1260 comprises several functional blocks of program
5 code. One block 1261 when executed by the processor causes the
6 scanner to capture an input image of a source document upon
7 initiation of the "start copy" key by a user. The captured image 1231
8 is stored by the processor 1210 in an area of the temporary RAM .
9 Another block 1262 causes the processor to generate a pattern of
10 positional markings. A further block 1263 causes the processor to
11 modify the captured image to add the positional markings. A still
12 further block 1264 contains the instructions needed to cause the
13 processor to instruct the printer to print the modified document. A
14 final block 1265 causes the photocopier to instruct the modem send
15 an image of the scanned document to a remote server, typically as a
16 bitmap or perhaps a compressed image in a format such as
17 Postscript or PCL.

18
19 The controller in effect modifies the scanned image to produce a
20 modified image to be printed. In this example the modification
21 comprises the addition of a pattern of positional markings.

22
23 It is advantageous not only that the pattern applied is unique for a
24 document- or each of a set of copies- but that it also encodes some
25 additional information such as the photocopier identity. This can be
26 achieved by reserving an area of pattern for a particular copier by
27 giving the copier its own ID or perhaps by storing along with the
28 pattern used and the image of the document some information such
29 as the copier identity, time of copier, user ID etc. This information
30 could be stored in a separate file attached to the document image
31 sent to the server.

1
2 The operation of the copier of Figure 9(a) is set out in the flowchart
3 of Figure 10 of the accompanying drawings.

4
5 In a first step 1300, a document to be copied is selected and placed
6 on the platen of the photocopier. The user then selects 1310 whether
7 or not to produce a "digital" photocopy (modified by the photocopy
8 controller) or a normal copy by pressing the "digital copy" button.
9 This sends an appropriate signal to the photocopier controller. Once
10 selected, copying begins by pressing the "Start" button. For ease of
11 explanation it will be assumed that the user has requested a "digital"
12 copy. It will be understood also that some photocopiers may not
13 provide the user with a choice but may in fact generate all copies as
14 "digital" copies.

15
16 After the Start button has been pressed, the scanner is initiated 1320
17 and the lamp and CCD are moved across the platen such that the
18 CCD captures 1330 an image of the document. This image is passed
19 to the controller which allocates or requests allocation of pattern from
20 a server to the document and then generates 1340 a pattern of
21 positional markings to apply to the captured image according to the
22 pattern that is allocated. The controller will in fact render a number of
23 different patterns depending on how many copies the user has
24 requested- 5 patterns may be generated for 5 unique copies, or 1 for
25 each of 5 copies. This will depend on the settings of the photocopier
26 which may be user definable.

27
28 Once the patterns have been produced the controller produces 1350
29 a set of modified images. Each will comprise the scanned image of
30 the source document embedded with the pattern. The pattern could
31 be embedded using a simple logical OR operation if the scanned

1 image and pattern are rendered in the same format and resolution.
2 Where the printer is a laser printer the scanned image and pattern
3 could be generated in any language which can be interpreted by the
4 printer, such as PCL or Postscript, or could be any other form of
5 bitmap or vector images.

6
7 The step of generating or creating 1350 the pattern can be performed
8 in a number of different ways. The following is a non-exhaustive list
9 of possible alternative processes:

10 -By randomly generating a pattern ID as a numerical seed and
11 applying it to an algorithm that generates a pattern in the device
12 space of the printer. This can be achieved if the controller pattern
13 generation block 1262 comprises a program, such as a JavaScript
14 applet which is called by the controller.

15 -By generating a pattern ID and accessing the pattern from a library
16 stored in the memory 1260. This requires a large library of pattern,
17 already created in the printer device space to be stored, or perhaps
18 stored in a form of shorthand to reduce the amount of memory
19 needed. For a very large pattern space it is envisaged that this may
20 prove impractical and the first alternative would be preferred.

21 -By requesting a pattern from a remote server using the modem 1250
22 or other network connection. Either an area of pattern rendered in
23 the printer device space may be requested, or just a pattern ID that
24 can be processed using the first alternative.

25
26 It could, of course perform a combination of these functions. For
27 instance, rather than returning a pattern to the copier a server may
28 instead return a pattern ID to the photocopier which in turn creates
29 the required pattern.

30

1 In the case of a photocopier which is linked to a remote server using
2 a modem or other network connection the controller may only have
3 the ability to request and receive pattern. The choice of which pattern
4 to use will be left to the server. The selection of a pattern could be
5 based on a number of requirements. For instance the photocopier
6 may identify itself to the server and this may influence the choice of
7 pattern portion used.

8

9 In a final step, the controller prints 1360 the modified images.

10

11 The photocopier may be used in a variety of different "digital" paper
12 document systems although one most advantageous system is
13 illustrated in Figure 12 of the accompanying drawings.

14

15 The system 1400 comprises a photocopier 1410 such as the
16 photocopier 910 shown in Figure 9(a) that is arranged to add a
17 pattern of positional markings at print time. This is connected across
18 a network 1420 to a server 1430 where an image of the scanned
19 document is stored along with the pattern allocated to a photocopy of
20 the scanned document. A pen 1440 is also provided which can be
21 used to write on the photocopied document. The pen 1440 is
22 provided with a camera (not shown) which detects the positional
23 information on the digital photocopy 1450 of an original paper
24 document 1405 as it writes and is also connected across the network
25 to the server. The server 1430 interprets the pen output to recognise
26 the document from the positional markings. By selecting an
27 appropriate pattern and cross-referencing this with the scanned
28 image on the server the system can therefore tell what is written and
29 where on a copy. Provided that each copy is given a unique pattern
30 and the pen has a unique ID which is contained in the information

1 sent across the network it is possible to tell who writes and which
2 copy.

3

4 Digital documents produced by the photocopier can be processed in
5 many ways. It is envisaged that an application can be provided which
6 merges the stored image of the scanned document with markings
7 made upon it by a digital pen and displays the merged image on a
8 screen. A user can then make manuscript markings on a digital
9 photocopy and easily transfer them to a computer screen. In an
10 alternative an application may be provided which simply identifies a
11 copy from its pattern whenever a user writes on it with a digital pen.
12 This could be used for document tracking or to check for
13 unauthorised use of a photocopy. It could be used in combination
14 with digital rights management systems.

15

16 The server on which the pattern information and copy of the scanned
17 image are stored need not be one and the same. For instance, the
18 photocopier may store the images in its own memory or on a
19 dedicated storage device connected to it across the network whilst
20 the pattern information is stored on a separate server. When a pen
21 writes on a photocopy the server is contacted which tells the pen the
22 address on the network at which the corresponding copy is stored.
23 This server could, for example comprise a central server on which all
24 pattern allocated by photocopiers is stored along with a network
25 address indicating which other server or storage device holds the
26 image of the document along with an application suitable for handling
27 the pen strokes. The central server contacted by the pen, on
28 receiving the pen strokes and recognising the pattern, will then return
29 the network address of the other server to the pen which thereafter
30 only talks to the other server. This would be more suited to use on a
31 wider scale whereas the first embodiment would be suitable for use

1 within a single company which has its own pens, photocopier and
2 server.

3
4 The operation of a digital paper system based around a photocopier
5 such as the one shown in Figure 9(a) is illustrated in Figure 12 which
6 provides a flowchart of a use of the system to manage copies of
7 documents.

8
9 In a first step 1500, the user starts making a copy of the document by
10 placing it on the photocopier. The photocopier then scans 1510 the
11 document and produces 1520 a digital photocopy by performing the
12 steps of Figure 10 of the accompanying drawing. In the next step
13 1530 the scanned image and the pattern associated with the
14 modified image- or something identifying the pattern- are sent to a
15 remote server and the modified document is printed 1540. If more
16 than one copy was requested then all copies would be printed at this
17 stage.

18
19 Once printed, a user can write 1550 on the document with a digital
20 pen which captures 1560 the users pen strokes and the pattern on
21 the document. The pen sends 1570 this information to a server which
22 stores the pattern read by the pen. The server interprets 1580 the
23 pattern and returns to the pen the identity of the document that is
24 being written upon.

25
26 The provision of a pattern of positional markings- such as the Anoto
27 pattern makes it possible to record, using an appropriate digital pen-
28 the position of writing on the paper. The unique pattern read by the
29 pen is sent to a server. The server knows where it is in the pattern
30 space and can look up to tell not only what document is being written
31 on but also where in the document.

1
2 In an alternative arrangement the photocopier may be arranged to
3 produce multiple different copies of a source document in which each
4 copy is different and in which a copy of the source document is
5 stored along with its modification to permit the identity of the copy to
6 be determined. This feature can be provided by a copier which does
7 not necessarily apply positional marking patterns but instead
8 modifies a set of copies in other ways. For example, a serial number
9 or barcode or other identification pattern could be applied. Since an
10 electronic copy of the source document is stored on a server or other
11 apparatus, or even the copier itself, the copy can be identified by
12 analysing the content of the copy. A barcode reader could be used
13 where the marking is a barcode, or a pen type device or other
14 scanner could be used.

15
16 Whilst it is known in the prior art to provide photocopiers which
17 modify scanned images to embed information the applicant is not
18 aware of any photocopiers which modify each of a set of copies in a
19 print batch in such a way that each is unique.

20
21 It will also be understood by the skilled person that we may provide a
22 printer, such as the printer shown in the accompanying drawings,
23 with the functionality described hereinbefore for the photocopier in
24 which case the original will be an electronic file rather than a paper
25 document. As with the photocopier described hereinbefore the printer
26 will modify each copy it makes by applying a different marking so
27 they can be distinguished from one another. Recording the original
28 together with the identity of the marking for each copy allows them to
29 be easily tracked. If a pattern of positional markings is used as the
30 marking it also allows the printer to generate a "digital" document
31 even where the original is not designed as a "digital" document.